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plants outside the garden fence that try the patience of the husbandman. He has learned the methods of remedying the others, but the floating spores defy his keenest eyesight to discern and baffle his ingenuity to combat. The ways of the fungi are however being slowly and laboriously revealed by the microscope and conquered by the spraying pump. The former assists the latter, which as yet somewhat blindly fires effective "small shot" into the enemies ranks.

Proper seeding, fertilizing, and weeding will do much to assist, in warding off the deleterious influences of fungous enemies for healthy plants, while not proof against their attacks, are less liable to be overcome by them. Let therefore everything be done that is possible before the last resort comes and then the fungicide will have the greatest effect and yield the most returns. If so much of the smut, rust, mildew, mold, rot, and blight of our cultivated plants is propagated by the wild plants hard by, it may be wise for every crop grower to pay attention to what is thriving outside his garden wall. He cannot build it high enough to shut out the spores, but he can do much to diminish the number of these spores. Having done this, he can take up the spraying pump with a brighter hope of future success. There was a carcass, so to speak, in the pasture and he went out and buried it. Fungi are the basis of contagion and they infect at long range by means of their myriads of invisible spores. To learn of their ways and find better methods of resisting them make the burden of many a station botanist's labor today.

Rutgers College, New Brunswick, N. J.

Noteworthy anatomical and physiological researches.

The stem and leaf of the mosses.¹

After alluding briefly to the principal works on the subject of his research, the author takes up the study of the anatomy of the aerial stem of mosses, distinguishing four types.

I. With uniform parenchyma containing chlorophyll bounded by: 1. A zone of aquatic cells; 1st type, *Sphagnum*. 2. An epidermal layer; 2d type, *Thuidium*.

¹BASTIT, EUGENE: — Recherches anatomiques et physiologiques sur la tige et la feuille des mousses. *Revue général de botanique*. III (1891.). pp. 255, 306, 341, 373, 406, 462, 561.

II. With parenchyma differentiated into a central cylinder and parenchyma containing chlorophyll. 1. Central cylinder uniform; 3d type, *Mnium*. 2. Central cylinder differentiated into a medullary region and a surrounding pericyclic zone; 4th type, *Polytrichum*.

In using the term "pericyclic zone," the author remarks that "as to its development, it is not comparable to the pericycle of the phanerogams, and in general, a strict analogy cannot be established between the tissues of the stem of the mosses, a product of the asexual spore, and the stem of the higher plants, a product of the egg."

From this pericycle and central pith arise the leaf traces, which diverge from the center according to a law constant for each species. The trace reaches its maximum differentiation at the periphery of the stem as it passes into the leaf costa.

In mosses with a central cylinder, branch traces are found arising by differentiation of the medullary tissue and the pericyclic zone. Here, also, the traces follow a law of divergence constant for each species.

For his study of the leaf the author uses *Polytrichum juniperinum*. He regards the chlorophyllose lamellæ as an assimilative tissue and "from analogy, comparable to the palisade cells of phanerogams."

The subterranean stem of *Polytrichum juniperinum* is worked out with very interesting results. The outline in cross section is bluntly (tri)angular, and instead of the concentric arrangement seen in the aerial stem, the tissues are grouped radially into three sets of structures. In the apex of each angle, adjacent to the epidermis, is a hypoderm bundle, bounded on the inside by the hypoderm sector. This structure, being more extensive at the periphery than the bundle, is adjacent to the epidermis laterally for some distance, and narrows rapidly toward the center forming a rude Y which includes the hypoderm bundle between its forks. In contact with the inner end of the stem of this Y is the crescentic pericyclic sector, placed with its concavity outward and transverse to the stem of the Y. Bounding this sector, along its convex inner surface, is the central pith. Filling the spaces along the sides of the (tri)angular section are the three isolated cortical regions extending from the epidermis to the central pith.

In *Dawsonia superba*, a new Zealand relative of *Polytrichum*, instead of a single hypoderm bundle, there are generally three arranged radially, increasing in differentiation as they approach the exterior. The origin of the hypoderm bundles is thus plain. Their first elements arise by differentiation of cells of the pericyclic sector, *i. e.*, the bundles are of internal origin. The remaining elements are added from the hypoderm by the differentiation of its cells.

The relation of the peculiar triangular radial symmetry of the subterranean stem to the circular symmetry of the aerial stem is worked out and the transition described. The sectors and bundles of the angles extend laterally until adjacent ends meet and at the same time the radial extension diminishes, thus gradually bringing the radial arrangement into the concentric.

The more important physiological results are here summarized.

When an aerial moss (*Polytrichum juniperinum* was used) is subjected to an aquatic life, the epidermal layer of the stem and leaf is profoundly modified. The size of the cells is enlarged, the cuticle disappears and the slightly thickened walls retain a cellulose nature. The leaf loses its chlorophyllose lamellæ, the limb is reduced and the form slightly modified.

If the mosses are grown in air or in water, and the conditions of light and the orientation of the stem are varied, the stems are found to be very feebly negatively geotropic, and strongly positively heliotropic. Heliotropism is always predominant, and young shoots always grow toward the light whatever be their position.

Under the influence of humidity of the air, the leaves of certain mosses take two positions upon the stem: one corresponds to the hygrometric state approaching saturation, the position of expansion; the other, to a state approaching dryness, the closed position. In passing from the open to the closed position or *vice versa*, the leaf executes movements in both longitudinal and transverse directions. The movements begin in the leaves at the base of the stem, and extend gradually to those at the summit. The cause of the movements is found in the contraction and the turgescence of the cellulose membranes of the leaf.

In both the open and the closed condition mosses respire in darkness, evolving CO_2 and absorbing O; the relation be-

tween their volumes remaining constant between 17° C. and 20° C. As regards the respiratory function, then, the mosses come into the general case of chlorophyll-containing plants. In the closed condition, the activity of the chlorophyll function (assimilation) diminishes nearly 50 per cent. The activity of both respiration and chlorophylline assimilation abates as the moss becomes dry. The inference may be made that these functions slacken during the summer with the mosses. It is in spring and autumn, when they are continually moist, that they elaborate nutritive materials most actively. This explains the appearance of the sporogonia during these seasons in so large a number of species.—RODNEY H. TRUE.

Anatomy of the stolons of Gramineæ.¹

Although the function of the stolons in the Gramineæ is nearly the same, being at once reservoirs of nutritive matters and organs in the service of the vegetative propagation, the author has observed several differences in the interior structure. And he claims at the same time, that the two general types of stolons, which have been proposed by another author, Mr. Johanson,² are not sufficient, when the question is to characterize the structure of these organs in general. The two types mentioned by Mr. Johanson were distinguished by the different arrangement of the mechanical tissue, which is either central with a large cortex in contrast to a reduced pith, or nearly subepidermal with a large pith and a reduced cortex. But the author enumerates now several other anatomical features, observed in stolons of different genera, which occur under different conditions. He shows from the numerous intergradations between the stolons under-ground and the shoots above-ground, that the organization of the stolon depends upon a modification of the above-ground shoot. The structure of the shoot above-ground is well marked by the position of the mechanical tissue, which is either truly subepidermal or more or less distinctly subcortical, the bark being as a rule not very strongly developed. But there is a large series of modifications between this form and those derived from such shoots as show a tendency to replace stolons.

¹ P. HELLSTRÖM: Naagra iakttagelser angående anatomen hos gräSENS underjordiska utlöpare. Bihang Kgl. Sv. Vetensk. Akad. Hdlgr. vol. xvi, no. 3, Stockholm, 1891.

² Kgl. Sv. Vetensk. Akad. Hdlgr. vol. xxiii, no. 2, p. 30.

Vol. XVII.—No. 4.